









Well 3D printing, my feeling is it came out of engineering practice and a bunch of probably blokes figuring out how to actually physically do it, and then design took it on and called it rapid prototyping, which of course it wasn't really. And now we've got it in art colleges where people are kind of abusing it and using it in interesting ways. So in a sense 3D printing is a tool, just like any of our other tools.

**SSE Academic 1:** It's an assembly tool really isn't it, used to assemble materials rapidly, reasonably rapidly, in a way that you wouldn't be able to do it by other means, or it would be (inaudible word) to do so.

**DJCAD Technician 1:** (responding to SSE Academic 1) It is, Yeah Yeah... (inaudible word) So I suppose there is still a link there with the engineers in a sense because they are still building the equipment and developing it, but the designers and craftspeople on the art side: there is a link there but its kinda separate.

**DJCAD Academic 1:** I think as well, it's become a case of that knowledge being much more openly accessible in public: so my first experience of 3D printing coincided with again, [REDACTED], we had a really great computer instructor and he got the budget for us to build the pcs for the (inaudible word) and he actually ordered the components and explained to us how to put them together: motherboards and... I think that knowledge was quite kept under wraps for a long time and I think that more out in the open now, with arduino as well, and then it becomes accessible to practitioners like me who maybe have quality interests in technology, maybe have those traditional hand skills from jewellery for other disciplines where that's encouraged, and then we can combine them in very interesting and helpful ways.

**DJCAD Technician 1:** The tools have become easier in a way haven't they really. So building a computer: you don't have to build a computer anymore.

**DJCAD Academic 1:** Well it (technical knowledge) hasn't been out there because it's very profitable for it not to be out there. Its more out there now. We could have built these computers in the 80's but most people didn't have access to that knowledge which we now do, and now more people are more open to building things, repairing things. And talking about sustainability, maybe that is a route we absolutely need to go down: we need to teach children in school how can I fix my laptop, how can I extend its capabilities another six years by inserting a new chip (inaudible word) or whatever it requires... so I don't know.

**DJCAD Technician 1:** So in some cases are the disciplines becoming more blurred? You (DJCAD Academic 1) are becoming a computer programmer?

**DJCAD Academic 1:** If you are asking me then I would definitely say yes. I think for our graduates that's definitely something they maybe need to understand, that its not about being a jeweller in your studio anymore: but you can be a jeweller and then go into biology, bio art bio design, that's a really exciting area where maybe our skills, creative thought and the hand skills and knowledge of processing materials and technologies can contribute something. But its quite hard to make scientists understand that we have something that's interesting to learn. I don't know how you (SSE Academic 1) feel about that?

**SSE Academic 1:** Well one thing that I wanted to pick up on from what you said that I think is perhaps a common theme for all of us is, "No user serviceable parts contained" I hate that phrase: (DJCAD Academic 1 agreeing) it's so negative. Repurposing things, I've always thought is at the heart of: it's very creative you can say this is what it is, but to change something, to change its function significantly by modifying it, I think is very important and is very natural. So its negative on many levels not being able to tinker and repurpose it. And it's a very negative trend of society as a whole that we are taught that things are as they are: that they are a disposable hundred pairs of shoes; and it's a very bad thing across the board. If people are shown that if things can be modified; and its modifying thought as well: modifying ways of doing things: that's the way to the future.

**DJCAD Technician 1:** What you are maybe touching on is that, what I think of as a craft approach, of maintaining a craft approach to things: which is a lot about tinkering and playing around with things and finding out what materials do and what happens if you change that. Now I was just wondering if in your field, you (SSE Academic 1) consider yourself a craftsman at all?

**SSE Academic 1:** To an extent, I'm prepared to make modifications. For example, the materials research I do makes use of a lot of equipment which is borrowed from elsewhere. You've (Karen) probably seen it in [redacted] labs that there's things that you don't quite know why they are there: but they are there and they do a good job. But they are there for two...

(audio disruption 4 secs)

...from a catalogue to do this. Having limited resources is often the impetus of: I think Rutherford (Ernest Rutherford, nuclear physicist) said, "We haven't got the money, so we'll have to think.". In our lab we don't have much kit so we have to be very clever. At that time: twentieth century scientists, much of the advances they made were with some very limited equipment that you would consider craft, and craft was there: glassblowing was absolutely essential (DJCAD Technician 1 agreeing), to make evacuated tubes with no holes in them to speak of; the seal between glass and metal is incredibly difficult to get I'm sure.

All these advancements were only possible, seriously, were only possible from the viewpoint of actually demonstrating the phenomena, when people had hold of the craft required to produce them: so there's a feed-in in a sense in the opposite direction.

**DJCAD Academic 1:** It's a shame to think that glass and ceramic students are disciplines in crisis now in craft education. The teaching is being stopped and the facilities are being stripped: its nice to see that ceramics is experiencing a revival here.

**SSE Academic 1:** Are there no low temperature processes which are considered to be equivalent or...?

**DJCAD Academic 1:** I think for glassblowing you have to have the big kilns and its very skilled, so the students might not really think there is a future in it necessarily: if you've got something like social-digital that's got an appealing title, a future-orientated type of name, but when you say glass what can you do? You can become a glass blower its quite expensive to set-up after college, and moving onto galleries, galleries that are closing down completely. Its maybe not as attractive a proposition as it was.

**SSE Academic 1:** Yeah, I was just wondering if there were other techniques which would not so much replaced it but in terms of working in a similar artistic domain: like plastics obviously can be coloured and so on, but they don't have the lustre, they don't have the appearance and the hardness of a ceramic: you just know its hard when you see it.

**DJCAD Technician 1:** When you have courses like product design they feel like they can use any material. Ultimately they would have to go to craftspeople to get things made properly but we can prototype things up to that point. But at some point you need the makers: proper makers.

**DJCAD Academic 1:** Exactly, and that immediately opens something: discussions we are having in jewellery as well where people who do an apprenticeship, and I think you've got some samples there by a professional polisher. Design courses like we offer here could never reach that level of practicing in just the one skill. Then you have graduates: quite young graduates coming in and telling a person that's been polishing for sixty years, and it's a difficult dynamic and maybe that's happening in ceramics as well?

**DJCAD Technician 1:** Well I think so... I think the art courses are very short really. We shouldn't expect students to leave fully formed as makers because it takes a long time to learn how to polish as well as the other things you have to do I imagine.

**SSE Academic 1:** Yeah, in science the preparation of your sample is very important. There's a strong linkage I think between the appeal you are trying to get from a ceramic for example, glass: just polishing glass, and what you need to get optically flat surfaces. I was just reminded of the difference between flatness and smoothness: the length scale is so important as I'm sure you will know with coherent optics; everything has to be within lambda by 10, or one tenth of the wavelength of the light that you

are using, otherwise it would not be suitable for keeping the relationship between the waves basically, and you will not get the desired effect. So that's an extreme case of polishing: you have to obtain flatness and have local smoothness as well to reach this level otherwise you will get a scattering effect.

There is a relationship but of course we rely on machines for polishing a great deal and it is because you can define what you are trying to get in a way scientifically: "you want this", and I think it's more straight forward to say "well you've achieved it" than if you are trying to produce a piece of craftwork. A piece of art you made once at a certain grade of surface which is neither perfectly smooth nor rough, but it has the appearance you want to get from it, but of course that's hard to define scientifically, but what is appealing is very difficult to quantify.

**DJCAD Academic 1:** Have you heard of David Pye and the "workmanship of risk and certainty"? So that's quite an interesting craft theory, the idea that the workmanship of risk is the hand skill, where every time you engage in the process there is a risk of it going wrong. The workmanship of certainty then is something machine made. I mean Pye was writing in the sixties, so he had foreseen all these things that have since happened

It's interesting because we are having quite intense discussions about this in our department, a polisher who has all that experience with the material, direct experience working the material: has he got a higher certainty than a machine that is maybe not able to gauge what's happening in the same way?

**SSE Academic 1:** So many different levels I suppose: mechanically their hand to eye coordination could be such that they know what they are doing and could repeat it many times, so its possible to determine what the end product there will be then a tolerance. But to hit that, and to achieve what it is that you want, I wouldn't know: that's a different ball game.

**Karen:** I think one of the interesting things in my research is that I got some of my optical components diamond machined - that's just cut out 'perfectly' with a really good optical cutting machine – so I then used white light spectroscopy to measure that surface. I also measured the surface of the components that I'd CNC milled but then emery'd and polished by hand on the lathe. The surface quality that I had achieved was actually smoother than the diamond machine, but I am presuming that the form of the shape would have been preserved much better (on the diamond machined component) than me polishing by hand, because I've probably affected the ...

**SSE Academic 1:** ...the uniformity of the larger area.

**Karen:** Yes, so in a way its swings and roundabouts. One of the queries is, particularly from physics when everything needs to be characterized to such an nth degree: is this one of the things that perhaps makes scientists hesitant about working with craftspeople or within the creative industries because there is that, "every time we make something there will be slight differences between them", even though we



can, as you (SSE Academic 1) said with the glass blowing you can achieve great outputs at the end of the day, but it does take that experimentation and time to reach that end goal that you are trying to achieve.

**SSE Academic 1:** Put your pyro glass in the bin and get clay pots. (transcribed inaccuracy possible here) (laughter)

**DJCAD Academic 1:** Or do we maybe need the physicist who then trains as professional polisher in the interest of the end result: who can really relate to the end result.

**Karen:** One of the things I've experienced moving into physics is the fact that there absolutely is a craft and a particular practice each individual takes as they conduct experiments or as they preparing a sample.

**SSE Academic 1:** Yes, I have seen people with (inaudible word) pride, the pride that they have in the processes of assembling an experimental system of some form to measure something, which is difficult to measure: it takes a certain level of ingenuity and a whole set of skills come to bear on an optical table, for example. It looks just like a table with holes drilled in it, things seem to be held very crudely on it but they can be adjusted to less than a millionth of a meter (inaudible word), and so you can align things in the way they have to be to optical components and they will remain aligned. And so the pride and satisfaction in the work is a little different than the pride and satisfaction an artist or a maker in design might have. I think they are compatible; I don't see why there is any disjointment between them at all: I think they meet in a number of places.

**DJCAD Technician 1:** I think maybe using multidisciplines on a question is maybe an attempt to get Leonardo in the room. He was probably able to think on a problem from different directions with different prisms or mirrors I suppose you would call it. To go back to your original thing (question) that's probably the benefit of it; is getting different perspectives on the same issue.

## **Question 2 (27:30)**

**Karen:** Moving on to the second theme as well: how can different disciplines communicate better with each other? Using craft and physics for an example, the fact that we have already touched on that there are so many similarities between the materials that we are experimenting with and the experimental approach, yet our perceptions are arguably very different about what we actually do. So how can we communicate better: is it a question of verbal language or is it visual, is it coming up with sketches to try and communicate what we want to do in a collaborative project? How can we connect better as two seemingly polar disciplines to benefit one another?

**SSE Academic 1:** I worked for a while with [REDACTED]

**DJCAD Technician 1:** Oh you were involved in that, yeah yeah.

**SSE Academic 1:** So it's still ongoing, its slightly quiescent due to a lack of... one of the main ways we get money now is through the feed-in tariff from the solar roof (laughter) so we have a little while to wait before we can use it and spend it on something. [REDACTED] always impressed me because of his enviable skill of sketching – he was great. I don't know if he was any better or any worse than any other architect but he could just, within a very short period of time produce a sketch about what he was thinking. So if you can do that, a picture tells the story of a thousand words, so if you can sketch or render it in some visual way then I think its very important.

In science too, because if you can't draw a ray diagram then you certainly aren't going to make it: there's a commonality I think.

**DJCAD Academic 1:** That's really nice to hear especially as art students often question why they have to engage in drawing.

(overlapped talking)

**SSE Academic 1:**...sketching and drawing in science. Engineers are often very happy to do something and sketch it in a book or whatever formal thing they want to make. I think working with the Fulton workshop is quite important to them as well as they need people who can render their ideas and mill a piece of something. But you have to draw it out first, you have to be able to sketch, and you may well have to convert to old means of a drawing table and do technical drawing, but you have to be able to draw a perspective diagram of what it is that you want.

There will never be a commonality of language I don't think, verbal language. It's quite hard to be able to describe things. You have to work a long time with somebody before you have this empathy through language.

**Karen:** Do you feel as well with how instant to draw and communicate with a pencil as you say, do you feel like that's arguably more valuable than someone coming up with a detailed CAD drawing of exactly what they want in the sense that there is arguably less room for change or that dialogue between the disciplines? I guess with a sketch you can say, "I want something like this" but you are open perhaps to the outcome or the alterations rather than with CAD, or...?

**SSE Academic 1:** Yes, with quite a broad bandwidth toward what you ... you maybe don't even know what you want, and all your doing is giving a few notes to start something.

**DJCAD Technician 1:** I think it depends where you are in the process: initially, you can't be too fixed so sketching is better and a discussion. [REDACTED] I was looking at design teams working together and choosing people who aren't designers as well and I compared the two groups trying to design exactly the same thing, but one was just drawing and one was modelling it. [REDACTED]

[REDACTED] It was difficult because its two different groups of people, so I tried to get similar types of people together, I did a (inaudible word) profile on them. And so I got the groups together. We ran the two sessions at exactly the same time and presented the same problem to them which was to design a bike pannier. So it was kinda a simple thing in a way.

We found that the best in the drawing group: the best drawer took over and they all sat around the desk like this (head resting in hand) and kinda looked over his shoulder and it was all quite static. The group that was modelling things: so using blue foam and cardboard and things that were easy to use and didn't really need any skills at all apart from being able to saw. They were up and about, moving around, it was much more dynamic and you could see that they were getting on better, and communicating better.

I tried to measure it in terms of how often they were laughing and looking at each other and touch. So it was an attempt to measure how well they were getting on. So I would say that a lot of it came from [REDACTED] ideas about this middle space between a group of people. So you aren't talking directly and getting involved in how somebody is feeling; the focus is on the object that you are trying to work on. The interpersonal problems that you might come across, can be circumvented by, I think, by being really focused on prototyping.

**DJCAD Academic 1:** That's why the make spaces are great idea actually: as the technology is there but not at the center, its an aid and thread to connect people, but it is the interpersonal relationships that are the main driver.

**DJCAD Technician 1:** The interpersonal things are sometimes the problems that you are facing rather than the thing you are trying to do... 'she's not getting that' 'he's not pulling his weight' or whatever. So sometimes in a group there is an ideal size, probably of four or five people: its not very big. Once you start to get bigger than that it becomes a bigger management problem. And the benefits of having more input diminished to some extent by interpersonal problems.

**SSE Academic 1:** Designing group work is hard to do: it's not something I do a great deal of I have to say. Mostly I do one-to-one, it's maybe a comfort to me. I always send the students away with a side of A4 we have had in the discussion, because they will often come back to me and ask 'so where's that piece of paper we were working on?' and I'd say 'Oh I binned it' so I always give them it. I have found that to be very useful all round, but it is what it is. If you want to fill the space between somebody else or the space between members of the team, that's a very good aim, because that where the instances would

lie, its just defining them in a way that's flexible and useful, and probably speech is the best for that in many ways but you still can't be sure that the vision you have is anywhere near like the vision that someone else has.

**DJCAD Technician 1:** Yes, Yeah that's right.

**SSE Academic 1:** If you could arrive at it in some way that wasn't so limited by medium, which maybe this is what you (Karen) were getting at in today's ... augmented reality we could draw things or create colors that indicate what we are thinking about and this could be done in principle very easily with a, lets just say a computer of some form, the possibility of stretching things a bit more. But you would have to get good at using the tool.

**DJCAD Technician 1:** Well this is it yeah.

**SSE Academic 1:** Most people can just draw stuff.

**DJCAD Technician 1:** That's right yeah.

**DJCAD Academic 1:** But then again you are moving further away from the material reality.

**SSE Academic 1:** Its an abstraction, yeah. Particularly for you (DJCAD Academic 1) I think, its moving away from where you want to be; you want to be with the objects.

**Karen:** And moving on from this, as you say when you are having these discussions, is it also about making sure you are having discussions at regular intervals to ensure that you do stay on the same page.? When you're (SSE Academic 1) saying that you are communicating but you don't necessarily know if the person is understanding exactly what you are saying. When you are working between disciplines is it about battling your way through and having that intensive conversation or is it good to have that space between conversations where people can go off in their own directions and have that sense of freedom?

**DJCAD Technician 1:** Yeah I think people need to go off in their own directions and use their skillsets. My feelings generally and that if you are working on a project together are that things need to move back into the centre. I think a prototype is a nice way of expressing what it is you need: because a prototype

is something that is evolving and its based in material reality as well. We all have students that sketch out things then the reality between their sketch and what's possible is very different. Sometimes I think of myself as a reality tester: I encourage people to make things and that tests what its like in reality rather than conceptually in the mind.

**SSE Academic 1:** I've always imagined from my limited contact with architects that its like that as well. They need things to stand up when the wind blows, so the intimate relationship between the civil engineer, to really make a structure that will be there tomorrow, and the architect is very relevant, I wouldn't say its important, but its very relevant if you want to produce something which will physically be there.

**DJCAD Academic 1:** We've had some fun and productive sessions recently with 3D printing pens in the workshop, because its bridging that: some students can draw really well and then taking that into the third dimension and then you've got the material element to consider. The plastic doesn't always do what you want it to, and to get that skill of really translating your idea into a little model is a fun thing for us and a good learning tool.

**SSE Academic 1:** Yeah I think the rather more clinical way, or less ambiguous way a scientist would do this... if students want to measure the transmission of light of different wavelengths through a filter for example: you could sketch something and then there's the question of after the sketch of how you might set it up and what equipment you might use and then the detail about what equipment suitable or most suitable which comes down to a sort of consultancy. Because nobody should presume they would tell you anything about ceramics because you ([DJCAD Technician 1](#)) would tell them how to carry out the activity, but they may have ideas about what form they may want and refer back to you for your expert knowledge.

That's not really interdisciplinary working, its different disciplines supplying knowledge to create an artifact, which I think is different. You are still being creative: but you are being creative in a slightly different fashion. Your discipline's not bleeding into theirs, you're just there to say, 'do it this way'. A bit limiting, but if you want to get a job done. That tends to be how things go in industry: a project team is a sentient team of experts and you don't have a creative consultant, you might have a product designer, but not generally in with production. Teams are formed differently to achieve different aims. The slight difference between research and development I suppose: of whether a project is a development thing or if its blue skies: where you don't want to talk to people who have done it before- you want to talk to people who haven't done it before but narrowly failed and are more creative probably, in what they achieved and if they are satisfied with what they achieved. If they have a solution, a better solution, where you might not want to go down that path which is very well trodden, you need to start somewhere else. And that's much harder to get going: its much harder to do.

**Karen:** Anyone got anything else to say for that?

**DJCAD Technician 1:** No, I'm good.

**Question 3 (43:12)**

**Karen:** Okay, so the last theme is: What could realistic goals for interdisciplinary research be in the future? What are the key things that need to work for the benefit of working in an interdisciplinary project? We have already had a few emerging ideas this morning about relationships between people needing to work effectively. And its even about the question of if its as simple as booking time slots in with the people you are dealing with so you have that dedicated time rather than always having discussions in passing or just dropping in on people out of the blue. Is it about that balance between communication and doing as well? Because you don't want to discuss constantly and not actually produce anything. And who is responsible for the project? Who is guiding these projects so they can achieve? At the end of the day, as you say they need to have this output that both disciplines are happy with. So I don't know if anyone's got any ideas...

**DJCAD Academic 1:** I think its become more difficult now on an institutional level to engage in these projects. First of all the students are quite segregated: we are DJCAD, you (SSE Academic 1) are the School of [REDACTED] (School of Science and Engineering(SSE)): I don't imagine you get many DJCAD students in your lectures.

**SSE Academic 1:** Well only in the renewable energy program, we have people from sustainability: we share some of the lectures on energy in general.

**DJCAD Academic 1:** Then it becomes a question of entry requirements. Possibly people will need maths or physics

**SSE Academic 1:** Well interdisciplinary teaching is hard. To achieve any useful outcome is often difficult, simply for those reasons: the prerequisites are there. It itself throws up problems which is interesting: there has to be a shared, common language in physics and its very precise, there is a difference between power and energy and its absolutely critical if you have an electricity bill: its all about energy rather than power. And so going on about these things sometimes never strikes home with a set of students who aren't science-based or engineering-based students. And you feel this and its quite unnerving because it gets at something which is core to the nature of the science which we can't begin to explain till you can bite into these concepts

**DJCAD Academic 1:** Is that a language thing again?

**SSE Academic 1:** It's a language thing, but it's the precision of the scientific definition of words. The concept of force for example is always very difficult to teach and for young people learning science, so there's been many studies on the basic concepts, length is fine, time is fine, but when you get to force it becomes more difficult to .

It needn't be a limitation, but it doesn't help if you can't understand this kind of language and the implications of it. So I would say that's a barrier to progress even though sadly it's a very simple barrier. It's unclear how to overcome it, and if it is necessary to overcome it. I think it would be much better if it wasn't necessary to overcome it to make progress. So I think its okay for people to come up with things where they use the wrong scientific words, its doesn't matter, if there is a gem of creativity there it will still be helpful.

**DJCAD Academic 1:** I think personally, I believe very much in letting ... it's a shame as a university that we can't just sit into other people's lectures...

**SSE Academic 1:** Yes, students ask me this sometimes...

**DJCAD Academic 1:** ... just to sit there and let that language wash over you. I've tried this myself and been to a conference on structured light with talks all day. I can't say I know the first thing about what it even is.

**SSE Academic 1:** Was this Interior design sort-of based?

**DJCAD Academic 1:** No, more physics.

**SSE Academic 1:** Right, okay.

**DJCAD Academic 1:** I can't say I know much more about structured light than before except from having heard of the term obviously. But I think it's a shame in the university that its not possible for our students to sit in these lectures and just listen and let that wash over you and then maybe that inspires you to go back and think about these concepts that you are talking about in a different way, go back to the library and find an article on something that maybe catches your attention. Similarly, for physicists to come into our workshop to just see what happens there and how people work: people soldering, people hammering, people handling materials. It's a shame that the university closes that down in such a way.

**SSE Academic 1:** Its difficult to do, even on a simple level. I remember the college system we had till about ten years ago. The college board had DJCAD alongside science and engineering and they asked how can we facilitate basically what you (DJCAD Academic 1) just said, electives so the students had room for it. And so the first thing you have to solve is the timetable problem which is the main limitation. Its like car-parking, don't mess with it unless you have a good solution! And so you have to think about the times, you have to set aside one hour or possibly two hours which would probably be your lunch time 1-2pm, or evening 5-6pm. And then you will find you can timetable it because these are hours not used: and people would have to give up their lunch hours and they just couldn't do it. As my mother would say, 'dirty looks from everybody' it was a non-starter, they just wanted to discuss how great it would be if everyone could take electives rather than the practicalities of achieving, which is actually liberating time for people.

But as you say, what's stopping you from going to a lecture in psychology at say ten to 11am if they don't have anything going on and wish to see what's on?

**DJCAD Academic 1:** Would anyone even notice if you did that?

**SSE Academic 1:** No, they wouldn't and some of my students do do this. One or two of them have consistently don't this, so this is why I would be against this idea of cards and clocking-in. I wouldn't like to see any of that going on.

**DJCAD Academic 1:** Its this urge to monitor every single thing that we do, with the ref as well which make interdisciplinary collaboration really difficult. Then who gets the credit for it? Immediately when you are building a team, these power dynamics start to happen, and jealousies, and its not conducive to furthering what we do and that's knowledge generation. I just think it's a real missed opportunity and a shame.

**Karen:** And copyright is a very important thing in the sciences, arguably more so than in design where it's a lot more open and shared, there is a distinct difference, at least from my perception- you all might have a different opinion. How do you deal with the different expectations for what that end result ends up being: who is in control of that generated knowledge and how is that then shared or disseminated. Does it turn into a paper or public event? There's all these surrounding questions in the way that we deal with information could be arguably quite different. Is that something that needs to be overcome as well to improve disciplinary projects between the sciences and creative arts?

**SSE Academic 1:** I think the idea of a display is fine in science, its done with outreach of course. The main penultimate is through usually giving young people something to play with in a constructive way so there is a learning experience. Its not trying to achieve what we are talking about today but it is at least



a vector that allows school kids to talk to professors and often they do enjoy the experience as well and often you get funny messages from parents as well. Probably the funniest one I ever had was having the Sylvanian Families: the child was coming round with their mum (who was taking an older pupil round), She was very interested and kept whispering to their mum, and it was because she hasn't got baby panda, she only had a baby bear at home! I can't remember what the science was about now: oh yes it was a house that had converted to solar, and was modular with LEDs and a light to replicate the sun, which is always the disappointing thing: needing an enormous light to power the tiny LEDs.

So outreach seems to work but it's a different set-up. But the idea of having a display or gallery or whatever I think is a good lead into what you do if you work with your hands or are a maker and what other way do you have really. So I appreciate what you've (Karen) done here, it gives me a good understanding of at least some of the things you have sought to achieve.

**DJCAD Technician 1:** I think the way you are going about it as well: the team and interdisciplinary stuff you are always going to have somebody who is driving it. You (Karen) are the driver for this project, because the practicalities of getting other people involved -everyone's too busy or don't have the energy. This type of display is really good for me to understand more broadly what you were trying to do. So that's always one of your challenges when you approach somebody new is explaining what it is you're doing and what the relevance is and why its important and that you are not just somebody who is a bit annoying wanting your time y'know? (Laughter) So how do you get all that across?

**Karen:** And I think its difficult as well, in terms of perceptions, as particularly with technicians I end up having the perception that you are very busy (DJCAD Technician 1: Yes!) because you are very busy and you don't want to take up too much of your time, but at the end of the day, would it be more beneficial as I said to book a slot to sit down and talk about it.

**DJCAD Technician 1:** For me it would be, yeah.

**Karen:** And arguably that might save time in the long run as you would be able to have that more informed input into the development of the project rather than just doing one thing that might have been better having been done in a different way if I had had a chance to maybe sit down and explain.

**DJCAD Technician 1:** The thing that we tried to do together with the mirror and Perspex and all that was... your idea sounded alright but as we discovered it was extremely challenging, the reality of doing it. But that was a process of exploration for both of us in a way, so I was willing to try.

**SSE Academic 1:** I think it depends on where you are at in the creative process. Whether you would want a more free-form drop in saying I've got this idea and its over a coffee, or if you want a slot with

someone an hour a week or whatever where you would be interchanging between what I would consider consultancy, where in other words you want someone to offer their professional advice on a process that you wish to carry out, if I can strip it down to these really boring terms of what you are trying to achieve. 'I've got trouble with conceptualizing: I've got this idea and its about the interplay between colour and light but I'm not quite sure exactly how to pose it scientifically.' that kind of discussion is a much more conceptual one which you aren't going to get from asking 'What is colour? What is light?' that's not going to answer your question. So I think it depends on where you are at in a sense and what you are trying to achieve and what the project is trying to achieve. Is it a project or an individual as you said, that's another key thing. I think very often an individual has to own something, and open it up as it goes along. I think something that inventive with more than two people is hard unless it's a product like a new vacuum cleaner or something. But its hard to imagine up something: people talk about brain storming but I don't often feel they are really creative unless ...

**DJCAD Technician 1:** I'd say its useful very early on in the process. I suppose it can be used later on as well.

My approach with the likes of yourself (Karen) and other people has always been to try to make you independent, and I'm not sure that's always the most effective way of doing things but I suppose what I try to do anyway is skill people up enough so that they can then start to make their own mistakes and learn through those things. But maybe you need to occasionally ask for people to just do stuff for you, and in slightly more technical areas that's probably what you would have to do.

**SSE Academic 1:** If you want to get from A to B and the technical is fixed way rather than needing a consultative approach.

**DJCAD Technician 1:** Or an expert to do it.

**SSE Academic 1:** If you are sure you want to get from A to B and its not like to are getting to C. When at the time you arrive there (C.) and think you want to provide D, things get more complicated.

**DJCAD Technician 1:** That's right. And as you do stuff yourself you start to see other possibilities as well. But handing over a drawing to somebody: as you say, if its clear what you want then that's okay but what you miss out on are all the possibilities you are maybe passing by.

**Karen:** Yes, one of the challenges I have been having in this project is that I have been working between the Fulton building and in the metal workshop for quite a few of the metal-based optical components I have been making, and there is that difficulty of trust in the sense that in the Fulton building you have to tell them exactly how you want something made and then there is that trust that they then go and do

exactly as you said for the point of being able to characterize those particular pieces, whereas if I've done something on the lathe, which is not something I'm experienced in, but I can take notes of what needs to be improved, 'I've scratched something here' and you are able to have more of a dialogue with yourself in a way about that process and gradually improve it, whereas there is that element of trust and not knowing when you outsource activities. But I could make more of an effort to develop a dialogue with the technicians in the Fulton workshop about taking notes of everything that went right or wrong when you did this thing.

**DJCAD Technician 1:** Yeah, because they will inevitably be making decisions themselves as they go through the process, and probably filling in some gaps from your drawings and ideas and things. Because actually to spec something up to be made can be really challenging probably.

**SSE Academic 1:** The most useful response that I have found is... well it depends on how you regard it was well as I don't think its confined only related to the technical staff in the workshop. I felt myself drawn to saying that it was and making out that it is because they will usually say, 'well that doesn't work' or 'that won't work' 'you don't want to do it that way', but I do because there are many other things that I can't explain to you that I have to take into account. And so you need somebody who has quite a lot of bandwidth to be able to work with them, to be able to work to your particular requirements.

**DJCAD Technician 1:** Yeah (in agreement)

**SSE Academic 1:** So as a physicist I can tell you, workshop technicians will say, 'well that guy (SSE Academic 1), he knows nothing.' and think you can't make anything. But actually I could, but they don't know that, at least in another life. But they have a set of skills, they have some excellent skills and they can do that.

There was something I wanted to say but I think I've forgotten now. It will come back to me.

**Karen:** We have two minutes left is anyone's wanting to add anything extra that they want to say...

(Pause)

**DJCAD Technician 1:** I think we have covered quite a lot of ground there.

**Karen:** Yeah, I think its been really interesting having everyone's input and shared experience so thank you very much for all your help and suggestions

**End of recording**

**Time 1:03:37**